

Unit 9 – Blood and the Vascular System

Pleasant Valley High School
Anatomy and Physiology

- Blood:
 - Transports nutrients
 - Transports Oxygen
 - Transports waste and hormones
 - Maintains stability of interstitial fluid
 - Distributes heat

12.1 Introduction

- Slightly heavier and 4 times as viscous as water
- Forms mostly in red bone marrow and contains RBC and WBC, platelets (cell fragments) – make up *formed elements* or the solid portion of blood
- The liquid component is called *plasma*
- See Figure 12.1 for distribution of blood components

12.2 Blood and Blood Cells

- Volume varies by individual
- 45% RBC, WBC, and Platelets
- 55% Plasma
- The percentage composition is known as *hematocrit*
- An average adult blood volume is 5.3 quarts or 5 liters
- Men have more blood than women 1.5 gallons : 0875 gallons
- Plasma is a complex mix of: water, amino acids, proteins, carbs, lipids, vitamins, hormones, electrolyte, and cell waste

Blood Volume and Composition

- Called *erythrocytes*
- Biconcave discs – shaped due to transport of gases, it is an increase in surface area for gases to diffuse, also places the cell membrane closer to *hemoglobin* (oxygen carrying pigment)
- Each RBC is about 1/3 hemoglobin by volume
- *Oxyhemoglobin* – name given when hemoglobin is enriched with oxygen
- *Deoxyhemoglobin* – when hemoglobin has no oxygen
- Mature RBC do not have nuclei in order to make room for hemoglobin...thus they can not divide



Red Blood Cells

- For males: 4.6 – 6.2 million RBC per cubic millimeter
- For females: 4.2 – 5.4 million RBC per cubic millimeter
- *Hemopoiesis* – the formation of blood cells, occurs first in yolk sac of embryo, post birth it occurs in the spleen and liver
- Average life span of RBC is 120 days
- *Erythropoietin* – hormone that controls the rate of RBC production, kidneys and liver release it in response to oxygen deficiency
 - A negative feedback mechanism
- *Hemocytoblasts* – stem cells that become RBC or type of WBC

RBC Counts

- Vitamin B-12 and Folic Acid – great influence on RBC production and DNA synthesis
- Iron – absorbed in the small intestine
- Anemia – too few RBC or too little hemoglobin
 - Several specific types of anemia

Diet and RBC

- Macrophages – responsible for phagocytosis and destroy damaged or old RBC in the liver and spleen
- Hemoglobin breaks into *heme* (iron portion) and *globin* (a protein)
 - Heme breaks further into iron and a green pigment called *biliverdin*
 - Biliverdin breaks eventually into an orange pigment called *bilirubin* which when in combination with biliverdin, comprises bile pigments

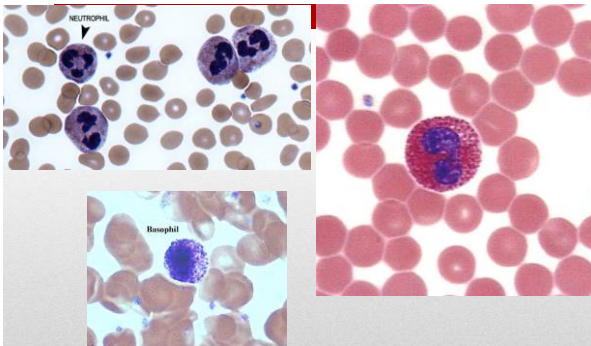
Destruction of RBC

- Called *leukocytes*
- Develop from hemocytoblasts
- Two primary categories of WBC
 - Granulocytes
 - Contain granules in cytoplasm
 - Usually 2 times the size of RBC
 - Develop in bone marrow
 - Have life span of approx. 12 hours
 - Agranulocytes
 - No granules in cytoplasm

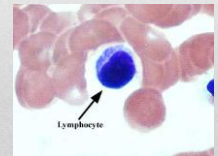
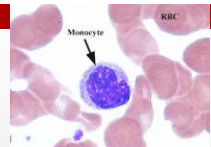
White Blood Cells

- Neutrophils
 - Fine granules, light purple when in neutral stain, 2-5 lobes in the nucleus, 54-62% of WBC
- Eosinophils
 - Coarse granules, appear red in neutral stain, 2 lobed nucleus, 1-3% of WBC
- Basophils
 - Few granules, blue in neutral stain, less than 1% of WBC

Granulocytes



- Monocytes
 - Largest blood cell, kidney shaped nuclei, 3-9% of WBC
- Lymphocytes
 - Large round nucleus, 25-33% of WBC



Agranulocytes

- Protect against infection through phagocytosis or antibody production
- *Diapedesis* – movement through blood vessel walls, allows WBC to leave circulation
- *Amoeboid motion* – self propulsion method of moving outside the circulatory system. Moves through interstitial fluid
- **WBC Counts**
 - Normal counts are from 5-10 thousand
 - Over 10,000 indicates and acute infection
 - Under 5000, indicates *leukopenia*
 - This is a deficiency that accompanies typhoid fever, the flu, measles, mumps, chicken pox, AIDS, or poliomyelitis

Functions of WBC

- **Differential White Blood Cell Count (DIFF)** – lists the specific types of leukocytes in a sample
 - *Based on the numbers of each type, a diagnosis can be made as to the disease attacking the body*
 - *Neutrophils increase during a bacterial infection*
 - *Eosinophils increase during parasitic infection and allergic reactions*
 - *Lymphocytes drop sharply in AIDS*
-

- Called *thrombocytes*
- Form from large cells in red bone marrow called *megakaryocytes* as a response to hematocytoblasts being prompted by *thrombopoietin* (a hormone)

Blood Platelets

- Liquid portion of blood
- Regulates fluid and electrolyte balance
- Transports nutrients, gases, and vitamins
- Maintains favorable pH

12.3 Blood Plasma

- Albumins – synthesized by the liver, maintain osmotic pressure of the plasma, regulates water movement between blood and tissue
- Fibrinogen – makes up about 4% of blood proteins, functions in coagulation of blood, made in the liver, largest of all plasma proteins
- Globulins – (alpha, beta, and gamma)
 - Alpha and Beta are made by the liver and transport lipids and fat molecules
 - Gamma are made in the lymphatic tissue and function as part of the immune system

Plasma Proteins

- Gases
 - Oxygen and Carbon Dioxide
- Nutrients
 - Amino acids, simple sugars, nucleotides, lipids (triglycerides, phospholipids, and cholesterol)
 - Lipoproteins – large, made of plasma lipid and protein, form because lipids are hydrophobic and plasma is 92% water
 - Classified based on density
 - Chylomicrons – triglycerides absorbed in the small intestine
 - LDL – high concentration of cholesterol
 - HDL – low density of lipids (includes cholesterol)

Gases and Nutrients

- Molecules that contain nitrogen but are not proteins
- Amino acids, urea, uric acid
 - Urea and Uric acid are released in urine

Nonprotein Nitrogenous Substances

- Essential in maintaining homeostasis
 - Sodium
 - Potassium
 - Calcium
 - Magnesium
 - Chlorides
 - Bicarbonates
 - Phosphates
 - Sulfates

Plasma Electrolytes

- The stoppage of bleeding
 - Step 1: blood vessel spasm – walls of the vessels are stimulated to contract upon injury, slows blood loss
 - May only last a few minutes
 - Step 2: Platelet Plug formation – platelets stick to collagen in the vessel linings
 - See Figure 12.12
 - Step 3: Blood coagulation – causes the formation of a blood clot

12.4 Hemostasis

1. Thromboplastin is released to cause production of prothrombin activator.
2. Prothrombin is an alpha globulin. Prothrombin is converted into thrombin and breaks fibrinogen into fibrin
3. Fibrin threads stick to damaged vessels and create a net like structure to trap cells and platelets
4. Resulting mass of cells is a blood clot

Blood Coagulation

- Positive feedback system – amount of prothrombin activator is proportional to the size of the injury. Thrombin acts on the clotting factors directly and uses more if necessary
- Fibroblasts break up clots when they are no longer needed
- *Thrombus* – and abnormal clot in a vessel
- *Embolus* – a moving clot within the bloodstream
- *Atherosclerosis* – fatty deposits in arteries that cause abnormal clotting
- *Infarction* – killing of tissue due to blood clot (*thrombosis*)
- Read about Coagulation Disorders on Pg. 319

- Agglutination – clumping of RBC after transfusion
- Antigens – surface molecules of RBC
- Antibodies – carried in the plasma, respond to the presence of incorrect antigens

12.5 Blood Groups and Transfusions

- Based on the presence or absence of two antigens on RBC
 - A antigen – Type A Blood, Antibody B
 - B antigen – Type B Blood, Antibody A
 - A and B Antigen – Type AB Blood, no antibodies
 - No antigens – Type O blood, both antibodies

ABO Blood Groups

- First studied in *Rhesus Monkeys*
- Includes several antigens in humans
- Most important is *antigen D*, if it is present along with any other, blood is said to be Rh positive...absent is Rh negative
- As in ABO types, wrong blood type will result in rejection
- *Erythroblastosis fetalis* – hemolytic disease of progeny from Rh positive and Rh negative parents
 - *First offspring is normal*
 - *Second or subsequent offspring will likely die in the womb*
 - *If the fetus survives, it will likely die shortly after death*
 - *Next two slides demonstrates this...graphic picture warning*

Rh Factor

